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A method for estimating the volume of Baltic timber products exported through the Sound and its application to Portugal, 1669–1815

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ABSTRACT

In this paper, I propose a method for estimating the volume of Baltic timber products exported through the Danish Sound, the strait separating the North Sea from the Baltic, during the early modern period. This method is based on the toll levied on the ships passing through the Sound. The main source used in this study is Sound Toll Registers Online. With the expansion of long-distance maritime trade during the early modern period, the Baltic played an important role by supplying naval stores (timber, pitch, tar, etc.) to the Western and Southern European nations. Until now exports of Baltic timber products have been analysed in terms of either the number of pieces or their weight. Both these approaches fail to shed light on the size (width, thickness, length) of timber products. On the other hand, the estimates presented in this article provide a clear picture about the size, hence the volume of the various timber products.

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1. Introduction

One of the most important sources to examine the commodities entering or exiting the Sound, the strait separating the North Sea from the Baltic, during the early modern period is the Danish Sound Toll Registers (STR). In this paper, I have used the digitised version of the STR, namely Sound Toll Registers Online (STRO)[1], to develop a method for estimating the volume of Baltic timber products exported through the Sound. This method, in turn, has been applied to estimate the volume of Baltic timber imported by Portugal from 1669 to 1815.

This paper is the outcome of the research conducted under the ForSEAdiscovery project (Forest Resources for Iberian Empires: Ecology and Globalization in the Age of Discovery). The object of this project is, *inter alia*, to investigate the timber imports into Portugal and Spain from the sixteenth to eighteenth centuries.[2] One of my colleagues in the project recently published a paper in which he presented a methodology for estimating the volume of Baltic timber imported by Spain (Gallagher, 2016).

The STR record the information related to the passages of ships through the Sound for the period 1497–1857. The STR give us information only about direct exports from the Baltic, and therefore, no estimates of re-exports of Baltic timber to Portugal are provided in this paper. Port of destination was recorded in the STR on an irregular basis for some years in the 1660s, but the first year for which the information is complete is 1669, which is hence the starting point of this investigation.[3] This study

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[1]The Sound Toll database is available at www.soundtoll.nl.
[2]The information related to this project is available at www.forseadiscovery.eu. For a brief introduction, see Solana and Nayling (2016).
[3]This can be verified from the website of STRO.

concludes in 1815, the year in which the United Kingdom of Portugal and Brazil came into being, and the capital was moved from Lisbon to Rio de Janeiro (Costa, Lains, & Miranda, 2016, p. 232).

Timber was the most important construction material in early modern Europe. It not only was demanded for building houses, palaces, churches, military defences, etc., but also assumed strategic importance as a primary raw material for the shipbuilding industry. With the expansion of the long-distance maritime trade in the sixteenth and seventeenth centuries, the Baltic played a crucial role as the supplier of naval stores (timber, pitch, tar, flax, and hemp) to England, the Netherlands, Spain, Portugal, etc. (Malowist, 1959, p. 179; Unger, 1959, p. 216). One of the reasons that the Baltic became a huge supplier of timber was the connectivity of its forests with the seaports through navigable rivers. The two important timber exporting ports in the Baltic, namely Danzig and Riga, were located at the mouths of the rivers Vistula and Dwina, respectively (Parry, 1967, p. 178).

Portugal, during the early modern period, required timber for varied purposes. The industries that demanded fuelwood included sugar refining, baking, ceramic, and metallurgical industries. The manufacturing of tools and furniture, and construction of fences for enclosures also created a huge demand on Portuguese forests (Reboredo & Pais, 2014a, p. 5). The population of Portugal increased from 1.1 million in 1636 to 3 million in 1821, and the resulting demand for fuelwood also led to the felling of trees (Reboredo & Pais, 2014b, p. 252). All these demands on forestland 'lead to a serious deforestation rate in the mainland' (Reboredo & Pais, 2014a, p. 5).

The shipbuilding industry also consumed forests in early modern Portugal. The demands from shipyards led to deforestation in various regions in Portugal in the sixteenth century. The repeated clearing of mountains in Algarve engendered deforestation, and to stem the situation, an order was passed in 1561 forbidding forest clearing. This was done to protect the woodlands and, in turn, the shipbuilding industry (Miranda, 2017, p. 78). The industries that depended on fuelwood were moved away from shipyards in order to preserve timber fit for shipbuilding (Reboredo & Pais, 2014a, p. 12).

According to Fernando Reboredo and João Pais (2014a, p. 12), the shipbuilding activity during the maritime expansion of Portugal from the fourteenth to sixteenth centuries resulted in the 'destruction of almost all the oak forests between the Douro and Tejo (Tagus) rivers'. The exhaustion of timber and other related inputs required for building ships resulted in the decline of Iberian shipbuilding in the late sixteenth century, and the emergence of the Baltic as a source of timber put Portugal at a disadvantage relative to its northern competitors (Ozveren, 2000, pp. 78–79).

Portugal imported timber from Northern Europe as early as the fourteenth century (Reboredo & Pais, 2014a, pp. 11–12). Foreign trade with the Hanseatic League began in the last third of the fourteenth century, and Portuguese salt was traded for timber and cereals. Timber was also imported from Spain, the British Islands, and the Madeira Islands from the fifteenth to seventeenth centuries. Masts were one of the most important components in early modern ships, and Portugal used masts made of Nordic pine because of their appropriate dimensions.

The Baltic exported a wide variety of timber products, namely boards, deals, planks, staves, masts, spars to name but a few. The STR capture all these products, but the important question is this: How do we study the export of these timber products from the Baltic during the early modern period? What should be the basis of our analysis?

Unger (1959) presented his analysis in terms of the number of pieces of timber products exported through the Sound in the seventeenth and eighteenth centuries. He also discussed, in brief, the destination of Baltic timber. He made no reference to the different sizes of the various timber products in his analysis. To make the argument more clear for the reader, just assume that two ports lying to the west of the Sound imported five pieces each of timber products, and if the first port imported two pieces of masts and three pieces of staves, and if the second port imported three pieces of masts and two pieces of staves, then it would be erroneous to conclude that the timber imports were same for both of these ports. Werner Scheltjens, on the other hand, has presented his analysis of Baltic trade, which includes timber products, in terms of the weight (in tonnes) of the cargo. Scheltjens estimates 12 pieces of boards at 144 kg (2015, p. 173, n. 18). Both these approaches do not give us any idea about the sizes of the various timber products. A layperson who has never seen, say, a plank in

her/his life cannot get any idea about its size from its weight. A piece of wood weighing 12 kg can be of any size (width, thickness, length).

We can present a meaningful analysis of timber exports or imports only if we know the volume of the various timber products under discussion. The total number of pieces of each product can be calculated with the help of STRO, and if we know the volume of each product, then the volume of Baltic timber exported or imported by any region can be calculated. This paper accomplishes the second step of the above process by outlining the method for estimating the volume of timber products exported through the Sound. The method (Section 3) outlined in this paper is based on the comparison of toll rates, as calculated from STRO, with the ones provided in the nineteenth-century Danish source.

The rest of the paper is structured as follows. Section 2 will include a discussion on the STR. In the next section, the method for estimating the volume of timber products is then outlined. In Section 4, the application of the method is discussed by taking examples of six timber products (out of the total 29) imported by Portugal from 1669 to 1815. The limitations of the proposed method are discussed in Section 5, which is followed by a conclusion.

2. The sound toll registers

The Danish Crown controlled the Sound and levied toll on ships passing in either direction. The number of passages recorded in the STR amount to approximately 1.8 million for the period 1497–1857. This number of 1.8 million includes passages in both directions, that is, from the east to the west of the Sound, and vice versa (Gøbel, 2010, p. 305). The following information was recorded in the STR: date of passage of the ship through the Sound, cargo of the ship, port of departure and destination of the ship, and the amount of toll levied on the various products (some other details were also recorded, but are not relevant here).

Ships can also reach the Baltic from the North Sea by navigating through the Little Belt and the Great Belt, thus avoiding the Sound. Therefore, the cargo of ships that passed through these two belts does not figure in the STR. According to Pounds (1979, p. 279), shipping through the Great Belt was approximately 15% of the total shipping from the North Sea to the Baltic. Gøbel (2010, pp. 319–320) opines that few shipmasters took this route because it was not easy to navigate. The Little Belt, owing to the strong currents, was also not a real option. Another alternative to the Danish Sound emerged in 1784 when the Schleswig-Holstein Canal linking Tönning on the North Sea to Kiel on the Baltic was opened, but it never acquired any real significance. Finally, a fraction of the traffic took the overland route from Hamburg to Lübeck (Pounds, 1979, p. 279). In short, the STR capture the overwhelming majority of the maritime trade from the North Sea to the Baltic and vice versa.

Initially, questions were raised about the usefulness of the STR for studying the maritime traffic passing through the Sound. According to Johan Schreiner, the information on the flow of goods through the Sound had 'little to do with the facts'.[4] This pessimism was overturned by later generation of historians who studied the Baltic trade. For example, Aksel E. Christensen (1941), who studied the Dutch trade with the Baltic, believes that the STR are 'numerically complete and reliable with regard to statements about the ship, but incomplete with regard to the contents of cargo' (p. 32). Gøbel (2010, p. 321), on the other hand, opines that 'it [information about cargoes] provides a fair picture of the goods exchanged between the Baltic and the rest of the world. Evidence in the Registers is probably correct but not complete'.

There was an element of fraud and underreporting while declaring goods at the Sound so as to pay a lower toll. The ships were not searched by the customs officers on a regular basis, and the toll was levied on the basis of the papers presented by the agents of the shipmasters (Ahonen, 2005, p. 24, n. 12).Timber was difficult to hide in a ship because of its bulky nature. Pounds (1979) believes that it was 'the only commodity to be fully recorded' (p. 280). One cannot say with certainty how

[4]Quoted in Knopper (1976, p. 94).

precisely the STR record the flow of Baltic timber products, but broadly speaking, historians have accepted the usefulness of these registers for studying the maritime trade of Northern Europe in the early modern period.

The digital version of the STR is known as STRO.[5] STRO is not the exact copy of the STR because some of the less important details have been omitted (Draper & Veluwenkamp, 2014, p. 283). As far as this investigation is concerned, the relevant details are available in STRO.

3. Method for estimating the volume of timber products exported through the Sound

It is important to first explain the data set used in this article. As mentioned above, the STR provide the information about 1.8 million passages through the Sound from 1497 to 1857. For this study, only those passages (12,121 in total) were extracted from the Sound Toll database that originated from the ports east of the Sound, namely the Baltic ports, and terminated at any port in Portugal. The data were extracted for the period 1669–1815. All references in this article refer to this data set unless stated otherwise.

The second step was to identify the various timber products in the STR. The list of products available on the STRO website was helpful as a first step in the identification process, and this list was used along with other sources to identify 29 timber products.[6] The total volume of timber imports can be calculated only when we have the total number of pieces of each timber product imported by Portugal. The detailed process of arriving at the number of pieces of each timber product is outlined in Gallagher (2016, pp. 755–759). In brief, it included assigning a unique code to the different spellings of the same timber product. Secondly, the units in which the timber products were counted, such as *tylter* (dozen), *skok* (60 pieces), etc. were converted into a number of pieces.[7] The method outlined below for estimating the volume of Baltic timber products is different from the one discussed in Gallagher's article. His volume estimates are based on 'predictable dimensions' of timber products (2016, p. 752), and the 'conventions of historic shipbuilding' (2016, p. 755), whereas the estimates presented in this study are based on the toll that was levied on the various timber products in the Sound.

The primary source employed in this study to estimate the volume of timber products is *Kongelige Forordninger og Aabne Breve* (Schou, 1844). This source (henceforth Regulations), among other information, lists the toll that was applicable on the commodities passing through the Sound in the year 1842. The toll rates (toll per piece) on timber products calculated in this article clearly indicate that the rates did not change significantly from the late seventeenth to early nineteenth century, and therefore, can be used for estimating the volume of Baltic timber products imported by Portugal from 1669 to 1815. The Regulations list all the products in alphabetical order with the corresponding toll that was levied on them (Schou, 1844, pp. 473–510). The toll on timber products was levied either on the basis of their dimensions (length or thickness), or a specific toll was levied on them, that is, the toll was levied on the number of pieces of a product. The toll rates and the corresponding dimensions of the various timber products are mentioned in the Regulations. The method outlined in this article, as mentioned above, is based only on the toll levied on the various timber products, and therefore, can be easily applied to any region/port that exported or imported Baltic timber products during the early modern period.

The toll paid at the Sound was the most important variable for this study. It served two purposes. First, it was the starting point for the exercise of estimating the volume of Category A products (see below). The toll rates on the various timber products were calculated from the data set, and after a

[5]The basic information about the Sound Toll Registers Online Project is available in Gøbel (2010, pp. 305–324).
[6]See Johansen (1983, pp. 108–112) for a discussion on timber products.
[7]In some cases, the unit was given not in terms of pieces, but in terms of either currency or weight or *eendeel* (a some). Some of the examples are: 10 *skippund* planks, 100 *rigsdaler* planks, etc. There are only 73 cases in the data set and were not taken into account to estimate the total volume.

comparison with the rates mentioned in the Regulations, a decision was taken about the dimensions of the various timber products.

Second, the toll was helpful in detecting errors if they have crept in during the process of digitisation of the STR. A very low or very high toll rate in relation to other cargoes[8] of the same product indicates the need to check the particular passage with the original scans of the STR, which are available on the STRO website.

The process of calculating the number of pieces of any particular timber product is explained in Table 1.

In the first case, the total number of boards is given by the product of amount column and unit of measurement column, that is, 4980 multiplied by 1. In the second case, the unit of measurement is not mentioned in the STR. Can we assume that it simply means '7032 pieces of "ordinary boards"'? Can we check whether our assumption is correct? It is interesting to note that the toll on timber products did not change significantly throughout the period under consideration. In the second case of the above example, if we calculate the toll levied on boards by accepting the above assumption, and compare it with the first and the third case, we find that it is identical, that is, 0.036 *skilling* per piece. This assumption of the unit being equal to 1 whenever it was not recorded in the STR has been extensively checked, and in almost all the cases, it was found to be correct. In a few cases, both the unit and the toll were not mentioned, and such cargoes were also taken into account for calculating the total volume.

The toll in the Regulations is given in terms of 'specie *rigsdaler*' and '*stiver*', moneys of account in early modern Denmark. The prefix 'specie' simply refers to the metal (silver) used to mint the *rigsdaler* coin. On the other hand, the information in the STR is given in terms of '*rigsdaler*' and '*skilling*'. '*Skilling*' was a coin in Denmark. What is the relation between the toll rates given in the Regulations and the STR? McCusker (1978, p. 81) gives us the following relation between *rigsdaler*, *stiver*, and *skilling*: 1 *rigsdaler* = 48 *stiver* = 96 *skilling*.

The Sound Toll Customs House at Elsinore used the exchange rate of 1 *rigsdaler* = 48 *skilling* throughout the period under consideration in this article, and this can be easily verified with the help of records available on the STRO website. Therefore, the toll rates in the Regulations can be used as if they are given in terms of '*rigsdaler*' and '*skilling*'.

On the basis of the information available in the Regulations, the various timber products were categorised, for the purpose of estimating their volume, into the following two categories.

Category A: The toll on the following timber products was levied either according to their length or their thickness: Boards (*bræder*), deals (*dehler*), laths (*lægter*), planks (*planker*), ledges (*ribber*), *sparrer*[9], *stigetræer*[10], masts (*master*), spars (*spirer*), bowsprits (*bugspryd*), yards (*raaer*), boathook shafts (*baadshagestager*), rods (*stænger*), flagpoles (*flagstænger*), shafts for wooden shovels (*skufstænger*), and ricker (*rikker*).

Category B: Specific toll, that is, the toll on the number of pieces of a product, was levied on the following timber products: Balks (*bielker*), clapboard (*klapholt*), French wood (*franskholt*), oars (*aarer*), staves (*staver*), pump wood (*pumpetræer*), wooden shovels (*træskuffer*), handspikes (*haandspiger*), compass timber (*krumholt*), treenails (*trænagler*), wales (*barkholter*), and wainscot (*vognskud*).

Some of the products listed above were further broken down into their subtypes for the purpose of estimating their volume, and the complete list of products is given in Appendices 1 and 2. Some minor products were subsumed in the above two categories, but are not listed here. The two timber

[8]The term 'cargo' refers to the total occurrences of a particular timber product in the data set; it does not refer to the total number of pieces of that product. For example, if Portugal imported 200 cargoes of planks from 1669 to 1815, these 200 cargoes then may contain, say, 5758 pieces of planks. To keep it simple for the reader, only the number of cargoes is mentioned in the text. In the final analysis, the volume of the total number of pieces of each product has been calculated.

[9]*Sparrer* roughly translates to 'rafter'.

[10]The English translation of `*stigetræer*´ is not clear to this author, and therefore, the Danish name has been retained. There are only 110 pieces of *stigetræer* in the data set.

Table 1. Relevant variables from the passages in STRO.

Passage id	Port of departure	Port/region of destination	Amount	Unit of measurement	Commodity	Toll
1745732 (15.12.1730)	Stockholm	Lisbon	4980	*stk.*	*bredder*	3.5 *daler* 12 *skilling*
528814 (26.04.1739)	Stockholm	Lisbon	7032	–	*ord. breder*	5 *daler* *14 skilling*
1089246 (21.07.1814)	Stockholm	Portugal	120	*tylter*	*ord. bræder*	1 *daler* *4 skilling*

Note: 1 *stykke* = 1 piece, 1 *tylter* = 12 pieces, 1 *rigsdaler* = 48 *skilling*.
Source: STRO.

products (kevel and small rods) are not mentioned in the Regulations, but their volume has been taken into consideration to estimate the total volume of Baltic timber imported by Portugal from 1669 to 1815.

4. Volume estimates of the various timber products

Due to the paucity of space, the method for estimating the volume of only six timber products is discussed in detail in this article; the volume for rest of the products has been estimated by employing the same method. To facilitate any revision in the total volume of Baltic timber imported by Portugal, the total number of pieces of each timber product is provided in Appendix 3. This information can be used in combination with the revised volume of each timber product imported by Portugal from 1669 to 1815.

4.1. Volume estimates of 'Category A' products

4.1.1. Boards (Bræder)

Three different descriptions of boards can be observed in the STR. The first two are '*bræder*' and '*ordinaire bræder*'; no further details are given. If the commodity name was '*bræder*', then it was considered, for the purpose of estimating the volume, as an '*ordinaire bræder*', that is, 'ordinary boards'. In the third case, descriptions such as '*bræder 6 alen*' are given in the STR. In this case, '6 *alen*' is the length of a board, where 1 *alen* equals 62.8 cm (Johansen, 1983, p. 128). There are boards with varying lengths in the STR. I have termed this category of boards as 'boards with length'. The volume of both the categories of boards has been estimated as follows.

4.1.1.1. Ordinary boards (Ordinaire bræder). Portugal imported 1874 cargoes of 'ordinary boards' from 1669 to 1815. The unit was not recorded in 33 cases, and the toll was not recorded in 41 cases. Both the unit and toll were not recorded in only one case.

The toll on boards was levied according to their length. The toll on 'ordinary boards' in the data set was levied at the rate of 0.036 *skilling* per piece. This toll rate, according to the Regulations, was levied on the boards with a length of 18 *fod* (5.6527 m) or less (Schou, 1844, p. 498).[11] According to Johansen (1983), Sweden specialised in the export of boards. It was the source of 87% (1629/1874) of all the cargoes of 'ordinary boards' imported by Portugal from 1669 to 1815. Therefore, it is reasonable to apply the estimates provided by Johansen to all the 'ordinary boards' imported by Portugal. Johansen (1983, p. 108) tells us that a board was 12–15 feet long, 12–15 inches wide, and 1–2 inches thick. To estimate the volume of an 'ordinary board', I have used the average length (13.5 feet or 4.1148 m), the average width (13.5 inches or 0.3429 m), and the minimum thickness (1 inch or 0.0254 m), as suggested by Johansen. The thickness of the 'ordinary boards' was less than that of the 'ordinary deals' and the planks, both of which have been assigned a greater thickness than 1

[11] *Fod* was a unit of length that corresponds to the present day 'foot'. 1 *fod* is equal to 31.4 cm, or 12 *tommer*, where 1 *tomme* equals 2.617 cm.

inch. The volume is given by the product of the three dimensions (length, width, and thickness) calculated above. The volume of an 'ordinary board' thus equals 0.0254 × 0.3429 × 4.1148, that is, 0.036 cubic metres (cbm).

4.1.1.2. Boards with length. Portugal imported 1349 cargoes of 'boards with length' from 1669 to 1815. The unit was not recorded in five cases, and the toll was not recorded in eight cases. Both the unit and toll were not recorded in only one case. The toll rate is same for both the 'ordinary boards' and 'boards with length'.

Again, Johansen's estimate of the width and thickness has been used. Regarding length, I have calculated the weighted average of the lengths with a frequency of 10 or more in the data set, and this frequency covered 1260 out of 1349 cargoes of 'boards with length'. The estimated length is equal to 13.7246 *fod* (4.3100 m). The volume of 'boards with length' equals 0.0254 × 0.3429 × 4.3100, that is, 0.038 cbm.

4.1.2. Deals (Dehler)

The following eight kinds of deals can be found in the STR: *dehler*, *gemeene dehler, ordinaire dehler*, *Preussiske dehler* (Prussian deals), *Svenske dehler* (Swedish deals), *Norske dehler* (Norwegian deals), *Stettinske deehler* (Stettin deals), 7 All. *dehler* (deals with length). There are deals with varying lengths in the STR. The first three types roughly translate to 'ordinary deals', and they have not been differentiated for the purpose of estimating their volume.

4.1.2.1. Ordinary deals (Ordinaire dehler). From 1669 to 1815, Portugal imported 1064 cargoes of 'ordinary deals'. The unit was not mentioned in 428 cases, and the toll was not mentioned in 56 cases. Both the unit and toll were not mentioned in 26 cases.

In the data set, the toll on most of the cargoes of ordinary deals was levied at the rate of either 0.036 *skilling* per piece or 0.6 *skilling* per piece. The toll differs from these two rates in a very few cases, and therefore, it will not affect the volume that has been calculated on the basis of the above two rates. According to the Regulations, the toll of 0.036 *skilling* per piece was levied on the deals with a length of less than 18 *fod* (5.6527 m) (Schou, 1844, p. 479).

According to Johansen (1983, p. 112), the size of an ordinary deal is comparable to that of a Swedish board (1–2 inches thick, 12–15 inches wide and 12–15 feet in length). I have used 1.5 inches (0.0381 m) as the thickness, 12 inches (0.3048 m) as the width, and 12.5 feet (3.8100 m) as the length of an 'ordinary deal'. The volume is simply the product of the three dimensions of a deal. The volume, therefore, equals 0.0381 × 0.3048 × 3.8100, that is, 0.044 cbm.

The toll of 0.6 *skilling* per piece was levied on the deals with a length of more than 21 *fod* (6.5948 m). In the data set, the toll on 2.4% of all the pieces of 'ordinary deals' was levied at the rate of 0.6 *skilling* per piece. I have used 7.4122 m as the length (see Prussian deals below for this figure) for the volume estimates. The volume equals 0.0381 × 0.3048 × 7.4122, that is, 0.086 cbm.

The 'ordinary deals' on which the toll was levied at the rate of 0.036 *skilling* per piece constituted 93.6% of the total pieces of 'ordinary deals' and 97.5% of the total pieces for which the toll is mentioned, and therefore, the volume estimate corresponding to this toll rate (0.036 *skilling* per piece) has been used for all the 'ordinary deals'.

4.1.2.2. Prussian deal (Preussiske dehler). Portugal imported 215 cargoes of Prussian deals from 1669 to 1815. The unit was not recorded in 20 cases, and the toll was not recorded in seven cases.

The toll on these deals, according to the Regulations, was levied at the rate of 0.6 *skilling* per piece (36 *skilling* for 60 pieces), which implies that the length was more than 21 *fod* (6.5948 m) (Schou, 1844, p. 479). According to Johansen (1983, p. 112), the Prussian deal was 27 feet (8.2296 m) long and 2 inches (0.0508 m) thick. I have used 7.4122 m (average of 6.5948 m and 8.2296 m) as the length of a Prussian deal. I have assumed that the width of a Prussian deal is equal to 12 inches

(0.3048 m), which is equal to the minimum width of an 'ordinary deal'. Therefore, the volume of a Prussian deal equals $0.0508 \times 0.3048 \times 7.4122$, that is, 0.115 cbm.

4.1.2.3. Swedish deals (Svenske dehler). From 1669 to 1815, Portugal imported 12 cargoes (59,830 pieces) of Swedish deals. The unit was not mentioned in eight cases, and the toll was not mentioned in 11 cases. Both the unit and toll were not mentioned in seven cases. There is no mention of Swedish deals in the Regulations.

In the only case in which the toll was mentioned, it was levied at the rate of 0.05 *skilling* per piece (in this case the total number of deals was 60). This is hardly a representative of the total number of Swedish deals, and therefore, I have also used the volume of 'ordinary deals' (toll rate was 0.036 *skilling* per piece) for Swedish deals. The volume of a Swedish deal equals 0.044 cbm.

4.1.2.4. Norwegian deals (Norske dehler). Portugal received six cargoes of Norwegian deals from 1669 to 1815. The unit was not mentioned in five cases, and the toll was not mentioned even in one case. It is important to note that Norway lies to the west of the Sound, and consequently, no ship destined to Portugal would have to pass through the Sound. All the six ships carrying these deals departed from Copenhagen.

There is no specific information in the Regulations about the toll on Norwegian deals, and consequently, the estimated volume of an 'ordinary deal' has also been applied to these deals.

4.1.2.5. Stettin deals (Stettinske dehler). Portugal imported three cargoes of Stettin deals from 1669 to 1815. Both the toll and unit were mentioned in all the cases. In the data set, the toll on these three cargoes was levied at a rate of 0.6 *skilling* per piece. The Regulations provide no information related to Stettin deals.

The volume of Stettin deal equals 0.086 cbm, which is the same as that of 'ordinary deals' on which the toll was levied at the rate of 0.6 *skilling* per piece.

4.1.2.6. Deals with length. Portugal imported 110 cargoes of 'deals with length' from 1669 to 1815. The unit was not recorded in four cases, and the toll was not recorded in one case. Both the toll and unit were not recorded in one case. The toll on these deals was also levied at the rate of 0.036 *skilling* per piece.

The thickness and width of these deals are the same as that of 'ordinary deals'. Regarding length, I have taken the weighted average of the lengths with a frequency of 2 or more in the data set, and this frequency covered 102 of 110 cargoes of 'deals with length'. The estimated length is 13.5686 *fod* (4.2610 m). The volume equals $0.0381 \times 0.3048 \times 4.2610$, that is, 0.049 cbm.

4.1.3. Planks (Planker)

The following four kinds of planks can be found in the STR: *planker, bohler* (thick planks), *skudeplanker*, and *skibsplanker*. Both *skudeplanker* and *skibsplanker* translate to 'ships' planks'. The word '*skude*' refers to the ships fit only for inland and coastal shipping (Harboe, 1839, p. 369), indicating that the planks needed for such ships are smaller than other types of planks.

Portugal imported 424 cargoes of planks, 40 cargoes of 'thick planks', 430 cargoes of *skudeplanker*, and 12 cargoes of *skibsplanker* during the period under consideration. In the case of planks, the unit was not mentioned in 38 cases, and the toll was not mentioned in 15 cases. Both the unit and toll were mentioned for all the cargoes in the case of 'thick planks'. In the case of *skudeplanker*, the toll was not mentioned in five cases, and the unit was not mentioned in 28 cases. The toll was not mentioned for three cargoes in the case of *skibsplanker*, and the unit was mentioned for all the cargoes. The volume of all the four types of planks has been estimated as follows.

According to the Regulations, the toll on oak planks was levied at the rate of 1 *rigsdaler* for 1 *skok*, that is, 0.8 *skilling* per piece (1 *rigsdaler* is 48 *skilling*, and 1 *skok* is 60 pieces). In this case, no length is

mentioned in the Regulations (Schou, 1844, p. 498). In the data set, this toll rate was applicable in the case of planks, 'thick planks', and *skibsplanker*.

The next rate of toll was 0.6 *skilling* per piece (36 *skilling* for 1 *skok*), and this rate was applicable on planks with a length of 21 *fod* or more. Because we need a length for a plank corresponding to a toll rate of 0.8 *skilling* per piece, I have added 1 *fod* to compensate for the toll difference of 0.2 *skilling*. The length of all the three types of planks corresponding to a toll of 0.8 *skilling* per piece is 22 *fod* (6.9088 m).

In the data set, the toll on *skudeplanker* was levied at the rate of 0.4 *skilling* per plank (24 *skilling* for 1 *skok*). According to the Regulations, this rate was applicable on planks that were 18–21 *fod* in length (Schou, 1844, p. 498). I have used 18 *fod* (5.6527 m) as the length of *skudeplanker*.

According to Johansen (1983, p. 108), a plank is more than 1.75 inches (0.0445 m) thick and more than 11 inches (0.2794 m) wide, and its length would vary between 12 and 24 feet (3.6576–7.3152 m). The thickness of a plank, according to *Dansk Marine Ordbog* (DMO), would lie between 2 and 4 *tommer* (0.0523–0.1046 m) (Harboe, 1839, p. 312). According to Albion (1926, p. 9), the thickness of a plank can lie anywhere between 2 and 8 inches (0.0508–0.2032 m). I have used 3 *tommer* (0.0785 m) as the thickness of planks and *skibsplanker*. The thickness of *skudeplanker* is equal to 2 *tommer* (0.0523 m). The 'thick planks', as the name suggests, differ from other planks in terms of their thickness. According to Albion (1926, pp. 9–10), if the planks had a thickness of more than 4 inches, then they were categorised as 'thick stuff'. I have assumed that the thickness of 'thick planks' is equal to 4.5 inches (0.1143 m). The width of planks, 'thick planks', and *skibsplanker* is equal to 12 inches (0.3048 m). The width of *skudeplanker* is 9 inches (0.2286 m). The volume of all the four types of planks can simply be obtained by multiplying the three dimensions.

The volume of planks and *skibsplanker* equals $0.0785 \times 0.3048 \times 6.9088$, that is, 0.165 cbm. The volume of a 'thick plank' equals $0.1143 \times 0.3048 \times 6.9088$, that is, 0.241 cbm. The volume of *skudeplanker* equals $0.0523 \times 0.2286 \times 5.6527$, that is, 0.068 cbm.

4.1.4. Masts (Master)

From 1669 to 1815, Portugal imported 285 cargoes of masts. The unit was not recorded in 141 cases, and the toll was not recorded in 11 cases. Both the unit and toll were not recorded in eight cases.

In the data set, the toll on masts was levied at the rate of 24 *skilling* per piece. This rate, according to the Regulations, was applicable on 'great' masts with a thickness of 15 *palm* or more (Schou, 1844, p. 496). The toll on masts, spars, boat masts, small spars, and flagpoles is mentioned under the same heading (*Master*) in the Regulations. Table 2 is based on the information provided in the Regulations.

Can we conclude that all imported masts were 'great' masts? Is there a possibility of verifying this from some other source? The Unpublished Sound Tables (UST) are the contemporary abstracts compiled from Sound traffic, and Åström has used them for his research (Åström, 1989). The figures reported by Åström on the export of 'great' masts to Lisbon in various years are provided in Table 3, and the same information based on STRO has been reproduced in the next column.

On the basis of comparison, it can be seen that the figures exactly match for four years. Except for one year (1800), the differences in 1785 and 1795 are not very significant. As a result, we can safely conclude that the masts imported by Portugal were, in fact, 'great' masts. The diameter of 'great' masts, according to Albion (1926, p. 284), was 20 inches or more. According to Malone (1964, p. 56), the diameter of 'great' masts was more than 18 inches.

Table 2. The toll rate and the corresponding thickness of masts

Toll per piece (in *skilling*)	Thickness (in *palm*)
>24	>15
8	7–15
1.2	<7

Source: Schou (1844, p. 496).

Table 3. Number of masts exported to Lisbon through the Sound, 1780–1825.

Year	'Great' masts according to the UST	Masts according to STRO
1780	70	70
1785	36	38
1795	5	0
1800	337	372
1805	50	50
1815	8	8
1825	79	79

Source: Åström (1989, p. 64).

I have assumed that the diameter of 'great' mast was 19 inches. Since a mast tapers from one end to another, I have used 18 inches (45.72 cm) as the diameter to estimate its volume. The circumference, therefore, is 143.6914 cm (the circumference equals $2\pi r$, where π equals 22/7, and the radius, 22.86 cm, is one-half of the diameter). If one *palm* equals 7 cm[12], then the circumference of 'great' mast equals 20.5273 *palm* (143.6914/7). The length of a 'great' mast equals 87.2410 ft (26.5910 m).[13] The volume is given by $\pi r^2 h$. The volume of a mast thus equals $\pi \times 0.2286 \times 0.2286 \times 26.5910$, that is, 4.367 cbm.

4.2. Volume estimates of 'Category B' products

4.2.1. Balks (Bielker)

Portugal imported 1263 cargoes of balks during the period under consideration. The toll was not mentioned in six cases, and the unit was not mentioned in 553 cases. Both the toll and unit were not mentioned in three cases.

An indication of the thickness of a balk, a squared timber product, comes from two shipments to Portugal. In the year 1843, balks with a thickness of 8 *tommer* (0.2093 m; passage id: 1377093) were exported to Portugal. In 1851, the thickness of the balks exported to Portugal was 12 *tommer* (passage id: 1611971); it is wrongly recorded in STRO as 72 *tommer*. According to Åström (1988, p. 124), both the width and thickness of a balk were equal to 9 inches (0.2286 m). I have used 8 *tommer* as the thickness for estimating the volume of a balk.

The toll on balks in the data set was levied at the rate 1.5 *skilling* per piece, and this rate matches with the one given in the Regulations (Schou, 1844, p. 475). Evidence of the length of a balk comes from a British source quoted by Johansen. According to the STR, 385 balks were exported to Bristol on a ship in October 1787 (passage id: 630391), but according to the British source, the number was 446. The length of these 446 balks was 14230 feet (Johansen, 1983, p. 99). Here, we are concerned not with the discrepancy between the two sources, but with the length of the balks. The length (14,230/446) of 1 balk, according to this British source, is 31.9058 feet (9.7248 m). The volume thus equals $0.2093 \times 0.2093 \times 9.7248$, that is, 0.426 cbm.

One cargo of *bohlholter* is also included in balks. The toll on *bohlholter* was levied at the same rate as on balks (Schou, 1844, p. 486). One cargo of *barkuner* (roughly translates to balks) is also part of balks. The toll on *barkuner* was levied at the same rate as on balks (Schou, 1844, p. 474).

4.2.2. Staves (Staver)

The volume estimates of three types of staves are presented here. According to the Regulations, the toll on staves was levied at the rate of 36 *skilling* for 1 large hundred or 48 *skok* (2880 pieces; 1 *skok* =

[12]One palm, as a unit of thickness, equalled 9.5 cm in Hamburg, 9.4 cm in Amsterdam, 6.9 cm in Riga, and 7.6 cm in London. Here, I have used 7 cm to calculate the volume, see Doursther (1840, pp. 373–375).

[13]According to Enn Küng, the length of 1 *palm* thick mast varied between 3.8 and 4 feet in the Netherlands; see Enn Küng (2011, p. 246, n. 20). According to Johansen (1991, p. 25), 1 *palm* thick mast corresponded to 4.67 feet in length. I have used 4.25 feet to calculate the volume.

60 pieces) of staves, which gives us a toll rate of 0.0125 *skilling* per piece (Schou, 1844, p. 503). This toll rate matches with the one in the data set.

The toll on staves from Sweden was levied at the rate of 1 *skilling* for 8 *skok*, that is, a toll rate of 0.002 *skilling* per piece. I have not calculated a different volume of these staves because only 101 out of the total 1487 cargoes of staves came from Sweden. In addition, 77 of these 101 cargoes were barrel staves, and these staves already have the smallest volume among all the three types of staves. The volume of staves is given by the products of their length, width, and thickness.

4.2.2.1. Pipe staves (Pibestaver). Portugal imported 353 cargoes of pipe staves from 1669 to 1815. The unit was mentioned in all the cases, and the toll was not mentioned in 33 cases.

According to the DMO (Harboe, 1839, p. 157), the length of the pipe stave varied from 62 to 64 *tommer* (1.6225–1.6748 m). The width and thickness were the same for all the three types of staves, according to the DMO. The width ranged between 4 and 5 *tommer* (0.1046–0.1308 m), and the thickness varied from 1.5 to 1.75 *tommer* (0.0392–0.0457 m). The average values have been used in all the three cases. The volume of a pipe stave equals $0.0425 \times 0.1177 \times 1.6487$, that is, 0.008 cbm.

4.2.2.2. Hogshead staves (Oxhovedstaver). From 1669 to 1815, Portugal imported 33 cargoes of hogshead staves. The unit was mentioned in all the cases, and the toll was not mentioned in only one case.

According to the DMO, the length of hogshead staves varied between 42 and 50 *tommer*. I have used the average length (46 *tommer* = 1.2038 m) to calculate the volume. The volume equals $0.0425 \times 0.1177 \times 1.2038$, that is, 0.006 cbm.

4.2.2.3. Barrel staves (Tøndestaver). Portugal imported 1101 cargoes of barrel staves during the time period under consideration. The unit was not mentioned in 17 cases, and the toll was not mentioned in 35 cases. Barrel staves were the most common types of staves, and therefore, when only 'staves' was mentioned in the data set, it was considered a barrel stave for the purpose of estimating the volume. Head staves (*bodenholt*) are also part of barrel staves.

According to the DMO, the length of a barrel stave varied from 40 to 42 *tommer*. The average length (41 *tommer* = 1.0729 m) has been used here. The volume of a barrel stave equals $0.0425 \times 0.1177 \times 1.0729$, that is, 0.005 cbm.

4.3. Total volume

The sum of the product of the total number of pieces of each timber product with their respective volume gives the total volume of Baltic timber imported by Portugal from 1669 to 1815. The volume of each timber product is given in Appendices 1 and 2.

The total volume of Baltic timber imported by Portugal from 1669 to 1815 equals 1,051,099 cubic metres. The share of the various timber products in the total timber imported by Portugal is shown in Figure 1.

In figure 1, boards include 'ordinary boards', 'boards with length', and wainscot. Planks include planks and wales. Deals include 'ordinary deals', Prussian deals, Norwegian deals, Stettin deals, Swedish deals, and 'deals with length'. Ship timber includes 'thick planks', spars, bowsprit, masts, boat masts, ships' masts, yards, small spars, compass timber, ricker, *skibsplanker*, *skudeplanker*, oars, ledges, kevel, handspikes, boathook shafts, flagpoles, pump wood, and treenails. The miscellaneous category includes barrel staves, hogshead staves, pipe staves, laths, rods, small rods, wooden shovels, shafts for wooden shovels, *sparrer*, clapboards, wood[14], *stigetræer*, and French wood.

[14]This category includes cargoes for which the description in the STR only mentions *træ*, *tommer*, or *holt* (all these terms roughly translate to wood or timber); no product name is mentioned in these cases. Portugal imported 26 cargoes (16,447 pieces in total) of wood during the time period under consideration.

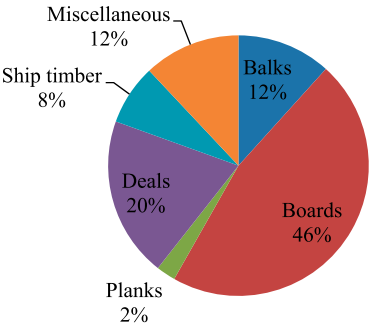

Figure 1. Share of timber products in the total volume of timber imported by Portugal from the Baltic, 1669–1815. Source: Appendix 4.

Figure 2 shows the volume of Baltic timber imported by Portugal from 1669 to 1815. These are decadal values, that is, the year 1670 refers to the total volume of Baltic timber imported by Portugal from 1670 to 1679, and so on. The value (23.6 cbm) in 1660 is for only one year, 1669, the first year for which the destination of ships passing through the Sound was recorded on a regular basis. The value in 1810 is for 6 years, that is, from 1810 to 1815.

The values from 1670 to 1719, in all probability, do not reflect the true picture of Baltic timber imported by Portugal. There are at least three reasons for these very low timber imports. The first relates to the exemption granted to Sweden from paying Sound dues until 1710 (Layton, 1993, p. 269). This exemption was granted in the year 1645 (Åström, 1965, p. 23). Owing to the exemption from paying tolls, the cargo of the Swedish ships was not recorded, and hence, the STR cannot be used to examine the commodities exported by Sweden for the period until 1710.

The volume of timber imports corresponding to the year 1710, that is, the timber imports from 1710 to 1719, once again, does not reflect the actual picture of that period. This is because of the fact that Denmark declared war on Sweden in 1709, and as a consequence, no ship under the Swedish flag passed through the Sound until 1721, the year in which the Great Northern War (1700–1721) ended.[15] From 1710 to 1721, the Swedish ships changed the colour of their flags, and the trade continued (Åström, 1988, p. 17). Therefore, it is difficult to examine this period with the help of STRO.

Finally, the timber exports from Gothenburg are also not reflected in the STR because it lies to the west of the Sound, and any shipment of commodities to Portugal did not pass through the Sound (Johansen, 1991, p. 23). Due to these three reasons, the volume of Baltic timber imported by Portugal from 1669 to 1815 is underestimated in this article.

5. Limitations of the proposed method

The volume estimates of the 'Category A' products are based on the toll levied on them at the Sound. These products constitute 77.8% of the total volume of the Baltic timber imported by Portugal from 1669 to 1815. The toll on these products was levied either according to their length or thickness. As a result, only one dimension, that is, length, out of the three required (length, width, and thickness) for estimating the volume of products such as deals, boards, planks, etc. is based on the toll, and the rest of the dimensions is based on the secondary sources quoted in the text. In the case of products such as masts, spars, yards, etc. where only two dimensions (length and thickness) are required to estimate the volume, only the estimate of thickness is based on the toll levied at the Sound; the second is based, again, on the sources quoted in the text. In sum, two different scholars working with the method outlined in this article can arrive at two different volume estimates for the same product.

[15]This information can be verified from the STRO website: www.soundtoll.nl

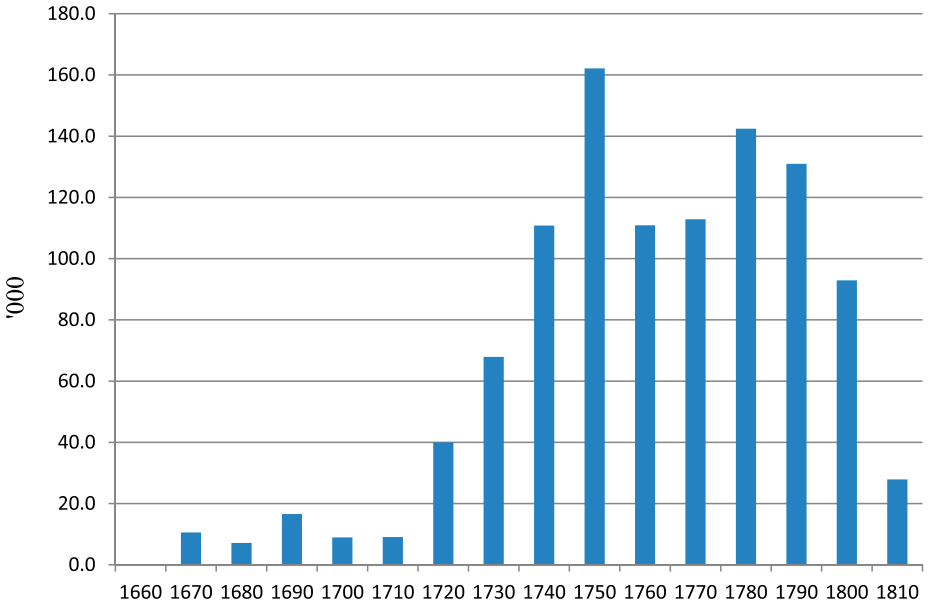

Figure 2. Volume of Baltic timber imported by Portugal, 1669–1815 (cubic metres). Source: Appendix 5.

A specific toll was levied on 'Category B' products, and hence the primary source (the Regulations) used in this article cannot be used to estimate their volume. Again, different volume estimates are possible for these products.

The toll rates for some of the products were not identical for the whole period from 1669 to 1815, and therefore, the weighted average of the different toll rates was used to estimate their volume. Needless to add, each and every difference could not be taken into account because of a large number of cargoes in the data set used in this study.

6. Conclusion

This paper outlines a method for estimating the volume of Baltic timber products exported through the Sound during the early modern period. It is based on the toll levied on the timber products at the Sound. This exercise became feasible only because of the availability of a digital source such as STRO. The export of timber products from the Baltic have been hitherto studied in terms of either the number of pieces or their weight. Both these approaches fail to communicate any information about the size of the various timber products.

The method discussed in this paper is solely dependent on the toll levied on the various timber products at the Sound, and therefore, can be fruitfully applied to any region/port that exported or imported Baltic timber during the early modern period.

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Dedication

This article is dedicated to his friend and colleague Fadi Hajj whose untimely demise has left a void in the ForSEA-discovery family.

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Appendices

Appendix 1

The volume of the following timber products is simply the product of their three dimensions, that is, thickness, width, and length.

Product	Thickness (m)	Width (m)	Length (m)	Volume (m^3)
Balks	0.2093	0.2093	9.7248	0.426
Ordinary boards	0.0254	0.3429	4.1148	0.036
Boards with length	0.0254	0.3429	4.3100	0.038
Clapboard	0.1275	0.1439	0.8374	0.015
Compass timber				0.300[a]
Ordinary deals	0.0381	0.3048	3.8100	0.044
Prussian deals	0.0508	0.3048	7.4122	0.115
Swedish deals				0.044[b]
Norwegian deals				0.044[b]
Deals with length	0.0381	0.3048	4.2610	0.049
Stettin deals	0.0381	0.3048	7.4122	0.086
French wood	0.1701	0.1635	0.9944	0.028
Kevel	0.0254	0.0508	0.3048	0.0004
Laths	0.0190	0.1524	3.8878	0.011
Ledges	0.1068	0.0534	7.8510	0.045
Planks	0.0785	0.3048	6.9088	0.165
Skibsplanker	0.0785	0.3048	6.9088	0.165
Skudeplanker	0.0523	0.2286	5.6527	0.068
Thick planks	0.1143	0.3048	6.9088	0.241
Wooden shovels	0.0078	0.1831	0.2878	0.0004
Sparrer				0.212[c]
Barrel Staves	0.0425	0.1177	1.0729	0.005
Pipe staves	0.0425	0.1177	1.6487	0.008
Hogshead staves	0.0425	0.1177	1.2038	0.006
Stigetræer				0.176[d]
Wainscot	0.0254	0.4572	3.0480	0.035
Wales	0.1524	0.3048	6.9088	0.321
Wood				0.028[e]

[a]This volume is taken from Miller (2000, p. 88). There are only 719 pieces of compass timber in the data set.
[b]The volume is the same as that of 'ordinary deals'.
[c]This is the weighted average of volumes of two different kinds of *sparrer*. The two volumes are 0.322 cbm. and 0.176 cbm., and their respective weight is 24.42% and 75.57%.
[d]The volume is the same as that of *sparrer* (0.176 cbm.). The toll on *stigetræer* was levied at the same rate as that on *sparrer*. There are only 110 pieces of *stigetræer* in the data set.
[e]The volume is the same as that of French wood. The toll rate for approximately two-thirds of the pieces of this product was similar to that levied on French wood.
Source: See text for the volume estimates of the various timber products discussed in this article. The volume for rest of the products has been estimated with the same method.

Appendix 2

The volume of the following timber products is calculated according to the formula $\pi r^2 h$, where π is 22/7, r is the radius, and h is the length.

Product	Radius (m)	Length (m)	Volume (m^3)
Boathook shafts	0.0457	3.1404	0.021
Bowsprit	0.1150	14.2494	0.592
Flagpoles	0.0425	5.8293	0.033
Handspikes	0.0327	1.5702	0.005
Masts	0.2286	26.5910	4.367
Boat masts	0.0450	6.4770	0.041
Ships' masts	0.0650	8.4201	0.112
Oars	0.0457	10.0492	0.066
Pump wood			0.019[a]
Ricker	0.0654	5.0000	0.067
Rods	0.1000	12.9540	0.407
Shafts for wooden shovels	0.0261	1.5702	0.003
Small rods			0.003[b]
Spars	0.1450	18.1356	1.198
Small spars	0.0550	7.7724	0.074
Treenails	0.0206	0.6096	0.0008
Yards	0.1200	15.5448	0.704

[a]The volume of a pump in a ship, in this article, has been estimated at 0.058 cbm. I have assumed that three pieces of pump wood were required to make one pump, and therefore, the volume of one piece of pump wood is 0.019 cbm.

[b]The volume is same as that of shafts for wooden shovels. There are only 410 pieces of small rods in the data set. Similar toll was levied on both of these products.

Note: See text for the volume estimates of the various timber products discussed in this article. The volume for rest of the products has been estimated with the same method.

Appendix 3

Total number of pieces of each timber product imported by Portugal from the Baltic, 1669–1815

Period	Balks	Ordinary boards	Boards with length	Clapboards	Compass timber	Ordinary deals	Deals with length	Norwegian deals	Prussian deals	Stettin deals	Swedish deals	French wood
1669				1320								
1670–9	1780			47,470		33,250	10,200	47,400	420		54,250	
1680–9	580	1368	12,500	26,310		73,401	3500	10,800	2700		5520	
1690–9	3457	2080		121,440	25	161,032	180		8940			
1700–9	3824			57,420		89,950			2680	540		
1710–9	767			16,800		162,105			450		60	
1720–9	4313	30,364		6120		717,986	3372		2070			
1730–9	4222	393,707	545,923	9648	527	514,926			870			
1740–9	14,609	804,628	349,340	8663		340,337	388,124		10,644	390		4590
1750–9	57,421	1,125,966	689,107	18,040	1	738,659	87,435		24,506	30		4290
1760–9	34,108	1,386,005	348,542	1680		372,171	2760		330			4420
1770–9	43,803	162,558	1,683,876	3308	54	263,411	1022		6172			19,874
1780–9	48,706	202,831	1,890,735	5547	112	117,966			26,475			25,159
1790–9	39,929	1,422,285	454,622	180		147,938			15,189			8397
1800–9	26,463	1,346,943		1500		75,384			1009			6510
1810–5	4389	381,920		120		13,728						

	Kevel	Laths	Ledges	Planks	*Skibs-planker*	*Skude-planker*	Thick planks	Wooden shovels	*Sparrer*	Barrel staves	Hogshead staves	Pipe staves
1669												475
1670–9		2000		1833	720	690				700	9000	15,020
1680–9				1230		450			1000	1069	4320	12,890
1690–9		200		8565	2430	390			3100	7200	1440	25,648
1700–9				2940	1335					4560	28,800	15,992
1710–9				304		4375			600	10,980	4800	59,245
1720–9		111		8541		10,665		44	2755	4320	720	34,518
1730–9		1794		3608		13,310			3016	303,600	77,100	297,600
1740–9		440		4755		44,409	1560	1392	10,558	1,668,934	67,130	1,095,980
1750–9		1462	1529	13,468	150	72,869	4105	1510	4706	1,795,377	25,380	1,176,625
1760–9		3170	1282	7992		19,216	210	2216	5270	992,039	2400	416,034
1770–9		822	4267	4678		17,466	668	1572	9337	416,728	3270	38,220
1780–9	60	2402	7824	14,560		33,539	4406	5900	17,449	2,377,634		
1790–9		232	1689	27,801		43,934		7348	9638	3,194,375		43,500
1800–9		53	1596	37,955		34,558		3374	7157	2,944,469		18,000
1810–5		609		16,343		26,127		1400	1820	1,114,397		47,400

	Stigetræer	Wainscot	Wales	Wood	Boathook shafts	Bowsprit	Flagpoles	Handspikes	Masts	Boat masts	Ships' masts	Oars
1669												
1670–9		1560	120						140		9668	
1680–9		1666		1620					198			60
1690–9		1510				67			399			1680
1700–9		240						400	219			6
1710–9		120					20		46			
1720–9			59			12	588	284	172			486
1730–9			38		1062	23	808	774	130			112
1740–9	32	84	136	24	877	31	1449	3874	330	692		1692
1750–9	18	172		51	1560	19	3254	9112	279	428	60	1693
1760–9	60	220		3310	4480	17	84	5007	566	168		284
1770–9		44		1420	1045	48		2468	710	459		89
1780–9		1165		451	30	262	1096	3884	1828	3785		978
1790–9		114		4531	320	22		5136	1871	2062		5543
1800–9				5040	61	141		10,075	588	702		4182
1810–5							68	2742	40	455		750

	Pump wood	Ricker	Rods	Small rods	Shafts for wooden shovels	Spars	Small spars	Treenails	Yards
1669									
1670–9						130			
1680–9									
1690–9					1200	325		6000	
1700–9	25					110			
1710–9						40			
1720–9					100	935			
1730–9					362	802		2000	
1740–9	64	1200				867	316	13,460	
1750–9		1195	301			1027	568	72,660	51
1760–9		2157	4			1185	56		6
1770–9		906	66			1106			58
1780–9		800	287	410		2558		11,640	70
1790–9		42	12			1764	48	400	80
1800–9						1060		4800	
1810–5		100				347			

Source: STRO.
Note: Blank fields represent zero number of pieces.

Appendix 4

Share of the various timber products imported by Portugal from the Baltic, 1669–1815

Product	Volume (m^3)[a]	Share (%)[a]
Balks	122,846.7	11.7
Boards	488,661.4	46.5
Planks	25,504.6	2.4
Deals	209,570.5	19.9
Ship timber	78,562.8	7.5
Miscellaneous	125,952.5	12.0
Total	1,051,098.5	100.0

[a]Rounded off to first decimal place.

Note: The above volume is simply the total volume of Baltic timber imported by Portugal from 1669 to 1815. For the products that form part of the above broad categories except balks, which is a stand-alone category, see Section 4.3.

Appendix 5

Total volume of Baltic timber imported by Portugal, 1669–1815 (m^3)

Period	Total[a]
1669	23.6
1670–9	10,564.9
1680–9	7147.9
1690–9	16,592.5
1700–9	8931.1
1710–9	9051.9
1720–9	39,989.5
1730–9	67,915.2
1740–9	110,805.7
1750–9	162,127.3
1760–9	110,872.7
1770–9	112,865.0
1780–9	142,430.3
1790–9	130,979.2
1800–9	92,893.4
1810–5	27,908.3
1669–1815	1,051,098.5

[a]Rounded off to first decimal place.

Note: The above values are the sum total of the volume of all the Baltic timber products imported by Portugal during the given period.